

THAT WHICH IS CLAIMED IS:

1. A method of enhancing performance of a body of monocrystalline cerium doped lutetium yttrium orthosilicate (LSO) in response to irradiation with high energy radiation, the method comprising:
diffusing oxygen into the body of monocrystalline LSO by heating the body for a period of time in an ambient containing oxygen.
2. The method of claim 1, wherein diffusing is carried out so that the body of monocrystalline LSO is fully oxygenated.
3. The method of claim 1, wherein diffusing is carried out so that the cerium is not further oxidized to a 4+ state.
4. The method of claim 1, wherein diffusing is carried out so that the body of monocrystalline LSO is not visually yellow in color.
5. The method of claim 1, further comprising forming the body of monocrystalline LSO to have at least one dimension no greater than about 20 mm.
6. The method of claim 5, wherein forming the body comprises forming the body to have a rod shape.

7. The method of claim 5, wherein forming the body comprises forming the body to have a rectangular shape.
8. The method of claim 1, wherein the oxygen containing ambient comprises air at atmospheric pressure.
9. The method of claim 1, wherein the oxygen containing ambient is at a pressure above atmospheric.
10. The method of claim 1, wherein the oxygen containing ambient has an oxygen concentration higher than in air.
11. The method of claim 1, wherein heating the body of monocrystalline LSO comprises heating the body to a temperature in a range of between about 1100° to 1400° C.
12. The method of claim 1, wherein heating the body of monocrystalline LSO comprises heating the body to a temperature of approximately 1400° C.
13. The method of claim 1, wherein the period of time is in a range of about 30 to 120 hours.
14. The method of claim 1, wherein the period of time is approximately 30 hours.

15. The method of claim 1, wherein prior to being enhanced the LSO single crystal consists of $\text{Ce:Lu}_2\text{SiO}_{5-z}$ where z ranges from approximately greater than 0 to less than 5.
16. The method of claim 1, wherein the diffusing results in increased performance based upon a light yield of the body of monocrystalline LSO.
17. The method of claim 1, wherein the diffusing results in increased performance based upon an improved energy resolution of the body of monocrystalline LSO.
18. The method of claim 1, wherein the diffusing results in increased performance based upon at least a 10% improvement in the energy resolution of the monocrystalline body.
19. A method of enhancing performance of a body of monocrystalline cerium doped lutetium yttrium orthosilicate (LSO) in response to irradiation with high energy radiation, the body of monocrystalline LSO having oxygen vacancies therein, the method comprising:
 - supplying oxygen to fill at least some of the oxygen vacancies in the body of monocrystalline LSO.
20. The method of claim 19, wherein supplying is carried out so that the body of monocrystalline LSO is fully oxygenated.

21. The method of claim 19, wherein supplying is carried out so that the cerium is not further oxidized to a 4+ state.
22. The method of claim 19, wherein supplying is carried out so that the body of monocrystalline LSO is not visually yellow in color.
23. The method of claim 19, further comprising forming the body of monocrystalline LSO to have at least one dimension no greater than about 20 mm.
24. The method of claim 19, wherein supplying comprises exposing the body of monocrystalline LSO to air at atmospheric pressure, and at an elevated temperature.
25. The method of claim 24, wherein supplying the elevated temperature is in a range of between about 1100° to 1400° C.
26. The method of claim 24, wherein the exposing is for period of time in a range of about 30 to 120 hours.
27. The method of claim 19, wherein prior to being enhanced the LSO single crystal consists of $\text{Ce:Lu}_2\text{SiO}_{5-z}$ z ranges from greater than 0 to less than 5.0.
28. The method of claim 19, wherein the diffusing results in increased performance based upon at least one of a light

yield of the body of monocrystalline LSO; and an energy resolution of the body of monocrystalline LSO.

29. A scintillation detector comprising:
a monocrystalline body having the general formula of $\text{Ce:Lu}_2\text{SiO}_{5-z}$ wherein z is approximately zero; and
said monocrystalline body also having a light yield of greater than approximately six times that of bismuth germanate (BGO).
30. The scintillation detector of claim 29, wherein said monocrystalline body also has an energy resolution which is at least approximately 10 % improved over that of a monocrystalline body having the general formula $\text{Ce}_{2x}(\text{Lu}_{1-y}\text{Y}_y)_{2(1-x)}\text{SiO}_{5-z}$ where x ranges from approximately 0.00001 to approximately 0.05, y ranges from approximately greater than zero to approximately less than 1.00, and wherein z is greater than zero.
31. The scintillation detector of claim 29, wherein said monocrystalline body has at least one dimension not greater than about 20 mm.
32. The scintillation detector of claim 29, wherein said monocrystalline body has a rod shape.
33. The scintillation detector of claim 29, wherein said monocrystalline body has a rectangular shape.

34. The scintillation detector of claim 29, further comprising a photon detector coupled to said monocrystalline body.
35. A scintillation detector comprising:
a monocrystalline body having the general formula of $\text{Ce:Lu}_2\text{SiO}_{5-z}$ wherein z is approximately zero; and
wherein said monocrystalline body also has an energy resolution which is at least 10% improved over that of a monocrystalline body having the general formula $\text{Ce:Lu}_2\text{SiO}_{5-z}$ where z is greater than zero.
36. The scintillation detector of claim 35, wherein said monocrystalline body has at least one dimension not greater than about 20 mm.
37. The scintillation detector of claim 35, wherein said monocrystalline body has a rod shape.
38. The scintillation detector of claim 35, wherein said monocrystalline body has a rectangular shape.
39. The scintillation detector of claim 35, further comprising a photon detector coupled to said monocrystalline body.